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## U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 133.

# Experiment Station Work,

## XVIII.

VALUE OF STABLE MANURE.  
ALFALFA AS A FERTILIZER.  
LIMING ACID SOILS.  
CELERY CULTURE.  
THE GREENHOUSE IN SUMMER.  
FROST-RESISTING STRAWBERRIES.  
FUMIGATOR FOR FRUIT TREES.

FOUNDATION IN COMB BUILDING.  
RIDDING HOUSES OF FLIES.  
SLOP FOR PIGS.  
PROFITABLE CROPS FOR PIGS.  
BARLEY FOR HORSES.  
WATER IN BUTTER.  
LOSSES IN THE SILO.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.



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# EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

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## EXPERIMENT STATION WORK—XVIII.<sup>1</sup>

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### THE VALUE OF STABLE MANURE.

In a recent report of the Oklahoma Station Director Fields makes the following statements regarding the value of stable manure, which apply to other portions of the country as well as to Oklahoma:

On the outskirts of every town in Oklahoma may be seen a collection of manure piles that have been hauled out and dumped in waste places. The plant food in each ton of this manure is worth at least \$2—that is what eastern farmers pay for similar material, and they make money by doing it. And yet, almost every liveryman has to pay some one for hauling the manure away. This is simply because farmers living near these towns are missing a chance to secure something for nothing—because, perhaps, the profit is not directly in sight. But from most soils there is a handsome profit possible from a very small application of stable manure.

On the farm of the Oklahoma Agricultural Experiment Station is an acre that has been in wheat for eight years. It had never been manured. In the fall of 1898 one-half of the acre was manured at the rate of 15 tons per acre and the other was left unmanured. When the crop was harvested, in the summer of 1899, the manured piece yielded at the rate of 30 bushels per acre and the unmanured yielded but 12 bushels per acre. An increase of 18 bushels of wheat was secured the first year from an application of 15 tons of stable manure. If all of the effect of the manure were exhausted the first season there were 18 bushels of wheat to pay for hauling about 10 loads of manure. But the effect is lasting and extends through a period of several years.

Here is a feasible plan to increase the wheat crop: Put every bit of manure obtainable into the soil. Eighteen hundred bushels of wheat will pay for one man and team hauling manure for 450 days, and the profit is directly in sight.

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<sup>1</sup> This is the eighteenth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

## ALFALFA AS A FERTILIZER.

The great value of alfalfa as a feeding stuff, especially in the Western and Southern States, is well understood. This has been established by long practical experience and by the scientific investigations of a number of the experiment stations. These investigations have not only demonstrated its value as a feed for all kinds of stock, including pigs and poultry, but have shown the stage of growth at which the plant contains the greatest amount of nutritive material and the best ways of curing and ensiling the crop.<sup>1</sup> The value of alfalfa as a fertilizer has, perhaps, not received so much attention, although a number of stations have investigated this phase of the subject. Professor Buffum, of the Wyoming Station, has shown that the crop is especially valuable for increasing the nitrogen of soils of the arid or semiarid region, for improving the tilth, and for destroying weeds by crowding them out. In experiments at this station it was found that land which had previously been in alfalfa produced \$8 to \$12 more value in wheat, \$16 worth more of oats, and \$16 worth more of potatoes per acre than land which had grown potatoes and grain before, and these "increases of yield and value were produced with absolutely no cost for fertilizing the land."

The results were obtained on land which had been in alfalfa five years, the crop being cut for hay each year, leaving nothing but the stubble and roots in the soil.

According to analyses reported by the Colorado Station, a ton of alfalfa hay contains 44 pounds of nitrogen, 8.27 pounds of phosphoric acid, 50.95 pounds of potash, and 40 pounds of lime. Alfalfa is a leguminous plant, and is therefore able to draw the larger part of its nitrogen from the air, thus causing an actual increase of nitrogen in the soil. It can readily be seen from the above figures that if the alfalfa is turned under a considerable increase in the available fertility will result, but even if the crop is removed the soil is improved in tilth and fertility by the shading of the ground and the decay of the large deep-growing roots of the plant, as was demonstrated in the experiments above referred to.<sup>2</sup>

## EFFECT OF LIME ON DIFFERENT CROPS ON ACID SOILS.

In a previous bulletin of this series<sup>3</sup> attention was called to some of the results obtained by H. J. Wheeler at the Rhode Island Station in experiments with lime on upland well-drained soils which were more or

<sup>1</sup> U. S. Dept. Agr., Farmers' Buls. 56, 97, 105, and 124 (Experiment Station Work, I, p. 28; X, p. 15; XII, p. 24; XVII, pp. 25, 26; also this number, p. 27).

<sup>2</sup> For further discussion of this subject consult U. S. Dept. Agr., Farmers' Bul. 31.

<sup>3</sup> U. S. Dept. Agr., Farmers' Bul. 65 (Experiment Station Work, II), p. 21.

less acid, a soil condition found to be much more prevalent than is generally supposed. In the article referred to the general principles of liming as explained by recent investigations were briefly discussed and the behavior of a number of crops toward lime as determined in the experiments which had been made up to that time was noted. The experiments have since been continued and extended, and have given further information of practical value regarding the behavior of farm crops under liming on soils of the character described. Nearly 200 different kinds of plants have now been tested in these experiments. The principal results of the experiments may be briefly summarized as follows:

*Plants benefited by liming.*—Orange quince, black Tartarian cherry, early Richmond cherry, Burbank Japan plum, American linden, American elm, rhubarb, Australian saltbush, hemp, asparagus, red raspberry (Cuthbert), red and white currants, barley, oats, spring wheat, mangel-wurzels, chicory, onions, English turnips, sweet peas, balsams, and poppy.

*Plants not benefited by liming.*—Norway spruce, cranberry, cowpea, and flax.

*Plants giving inconclusive results with liming.*—Concord grapes, blackberry, raspberry (Ohio Blackcap), spring rye, serradella, and carrots.

While the soil conditions under which the above experiments were made are believed to be quite widespread, they are probably not universal, and therefore the results reported must not be accepted as applying to all conditions, but merely as indicating the crops most likely to be benefited to a profitable extent by liming. The action of the lime will depend very largely upon whether the soil is deficient in lime or is acid, and this can be determined only by chemical tests or by field experiments. The first can best be made by a chemist; the latter can be made very easily by the farmer himself.

## CELERY CULTURE.

Celery culture is an industry of commercial importance in a number of sections of the United States, and has also found a place in many private gardens. Celery is successfully grown from Maine to Louisiana and westward to the Pacific coast. Twenty-six experiment stations have reported work with this crop. From these reports the following brief discussion of celery culture has been prepared:

According to the Rhode Island Station celery growing first developed into an industry in this country in the vicinity of New York about 1858. Peter Henderson was one of the earliest growers and was most prominent in introducing improved methods of culture. Until some twelve or fourteen years ago celery was considered a

winter vegetable and the greater part of the crop was stored in the fall for winter use, but within this period the summer and fall demand for celery has developed so that now two crops are occasionally taken from the same field in one season.

Celery (*Apium graveolens*) grows wild in England and the eastern part of Europe. It has been known and cultivated to a certain extent, more especially for medicinal purposes, since before the Christian era, but it is only within the past one hundred years that it has become a comparatively common garden vegetable. The plant has taken two distinct lines of development, (1) the bottom has been enlarged into a turnip-like root which is eaten, and (2) the leafstalks have been thickened and solidified and made tender and palatable by bleaching. The stalks are eaten raw with salt as a relish, cut up to season soups, and used in salads, etc. On the continent of Europe the root form, generally known as celeriac, is more largely cultivated, but in America stalk celery is generally grown. In this article stalk celery only will be considered.

#### CULTURE.

In the culture of celery a rich, deep, loose soil, generally bottom lands or thoroughly drained and reclaimed swamp or marsh land, is recommended. Celery grown on upland is generally considered to be of better quality, while on moist lowlands it makes the better growth. Celery seed germinates slowly, requiring twelve to fourteen days. For the early crop it is usual to plant the seeds in February or March in shallow flats filled with loam. The seeds are sown on the surface and a little dirt sifted over them. The soil should be kept moderately moist. The flats may be stacked one upon the other until germination begins, or they may be covered with paper or like material and placed under the greenhouse bench or in the kitchen window. When the plants begin to germinate they should be gradually accustomed to the light. The plants are usually transplanted once or twice in boxes, the hotbed, or cold frame before being set in the field. According to Professor Taft, of the Michigan Station, seed for garden celery in the North should be sown early in the spring. A level spot should be selected or made rich with rotted manure, then—

Thoroughly pulverize the soil and sow the seeds in rows about 8 inches apart. The seeds are small and an ounce will produce over 5,000 plants. When the plants are 3 or 4 inches high the tops should be clipped to make the plants stocky. \* \* \* [When transplanted to the field] the rows may be 4 or 5 feet apart and the plants 6 inches distant in the rows. The plants should be set not deeper than they were in the bed, and the soil firmly pressed about the roots. When the plants are about 10 inches tall, the celery wanted for fall use should be banked up to blanch it; this operation should be repeated as the tops grow. The celery intended for winter storing should be earthed sufficiently to induce the stalks to grow upright. Celery will stand several degrees below freezing without serious injury. About the 1st of

November the plants should be placed in trenches or in the cellar to blanch for winter use. If stored, trenches should be dug 8 or 10 inches wide and as deep as the celery is tall. The earth should be loose at the bottom of the trench. The plants, with the roots on, are taken from the rows and packed closely in the trench with the tops even with the surface. As cold weather comes on the tops should be covered gradually with some loose material until they are protected from serious freezing. Celery may be placed in the cellar by having boards 8 or 10 inches apart to prevent packing in a compact mass. Soil should be placed about the roots that they may start to grow, as this growth in the trench or cellar blanches the stalk. Earth is not necessary between the stalks.

Celery is more difficult to grow in the South than in the North. According to the North Carolina Station it is difficult to carry plants through the long hot summer; but with good plants in September no difficulty is experienced in growing the crop. Relative to methods of starting the young plants and of the cultural operations in the field Professor Massey, of that station, states as follows:

The best place to sow the seed is on a moist border, shaded from the south sun by a board fence. Put the bed in the finest order, and mark shallow lines across it not over half an inch deep and wide enough apart to allow a small hoe being used to work the plants. Sow the seed rather thickly on these lines and then pat them down with the back of a spade, which will cover them sufficiently. Now spread over the bed some old bagging, and with a sprinkler water the soil on top of the bagging. Watch the bed closely, and as soon as the seeds begin to germinate raise the cover off them, but keep it over them and propped up on stakes to shade the bed. When the plants are an inch or two high and large enough to handle, transplant them to a similarly situated bed and allow 2 inches between them, at the same time nipping off the tap root to an inch long. This transplanting I consider essential to get plants of the proper robustness to transplant later. The celery plantation should be made on the most moist land in the garden, where some early crop has been grown that required heavy manuring, for we prefer not to add manure to the land at planting time. If some additional manure is needed it is best to use a high-grade fertilizer that has a good percentage of nitrogen (ammonia) and potash at the rate of a ton per acre, well worked into the soil, broadcast where the beds are to be planted a week before setting the plants. The tops should be sheared once or twice in the bed before final transplanting, so as to get stocky plants. The seed should be sown late in April.

In the South the crop is not usually lifted as in the North for the purpose of storage and bleaching, but is bleached in place. Difficulty is sometimes experienced in keeping the plants from growing all winter and running to seed. In order to prevent this, the North Carolina Station advocates planting in beds 5 feet wide and of any convenient length, the rows to be 1 foot apart, the plants 6 inches distant in the row. This method of growing is more economical of labor, since it requires less work to bank or board up a bed of celery for blanching than to bank up the same number of plants in wide rows. Furthermore, wide rows earthed up are more exposed to the sun and are warmed to such an extent that the celery is kept growing.

The outer leaves of celery in growing have a tendency to spread out flat on the ground. The North Carolina Station states that in order

"to counteract this it will be found necessary to put it through what is called the handling process about the 1st of October. This is done by putting earth around it to hold the leaves upright, and no more than is sufficient to do this should be used, for the final earthing up should be delayed here until November and December. Any attempt to blanch celery early in the fall in this climate will result in a hollow, rusty, and inferior product. Christmas is about as early as we should expect well-bleached celery."

The Louisiana Station reports that it has been more successful in importing than in growing young celery plants and in growing in narrow beds as recommended above by the North Carolina Station. February, March, and the first part of April are considered the best months for blanching the celery in this State. At the Texas Station growing celery in beds with the stalks 6 inches apart each way was a failure. The intense heat kept the plants small and green and the weeds were difficult to keep out. In growing by the old method and heaping the dirt up around the plants as they grew more success was attained. The greatest success at the Kansas Station has been obtained when the plants were set 6 inches apart, a little above the bottoms and on the sides of furrows made with a stirring plow, and 4 feet apart. In subsequent cultivation the furrow was kept open and used as a ditch in irrigating. C. B. Waldron of the North Dakota Station summarizes his experiments in growing celery as follows:

The period of transplanting can not be safely delayed after June 1. Banking the celery when the soil is excessively dry, especially during warm weather, causes the celery to rot at the heart. To avoid both rust and rot heavy banking should not begin until cold weather in September. The best distance apart for the rows is 4 feet. Under this system alternate rows should be banked and bleached and then removed when the remaining rows are similarly handled. Celery for winter use, planted in boxes, cellars, or pits, should have the roots pruned back to 2 inches in length, and the bunches should also receive considerable top pruning, but the outer stalks should not be stripped off. White Plume is the best variety so far for general culture.

### FERTILIZERS.

Celery, like asparagus, requires an abundance of fertilizer. Well-rotted barnyard manure is generally advised. The soil can scarce be made too rich. The average analysis of 10 samples of water-free celery plants, as regards fertilizer constituents, is reported by the New York Cornell Station as follows: Nitrogen, 4.16 per cent; phosphoric acid, 0.81 per cent; potash, 3.23 per cent, and lime, 0.43 per cent. "While no conclusive results can be drawn from this one set of analyses, it seems probable that nitrogen and potash are the plant foods most required." In an experiment at the same station with commercial fertilizers, on flat muck land of half-wild meadow broken up the year of the test and which had never been fertilized, "wood ashes gave the best results,

although a combination of nitrate of soda, South Carolina rock, and sulphate of potash promise well. Muriate of potash excelled the sulphate. Nitrate of soda alone gave poor returns. The check (no fertilizer) plats were not worth the growing."

### BLANCHING.

Celery is blanched for the purpose of depriving it of its natural green color and of certain bitter properties, thus rendering it more palatable. The principle involved is the exclusion of light. This is usually accomplished by heaping earth against the plants (fig. 1). Boards about a foot wide are used for the same purpose (fig. 2). They

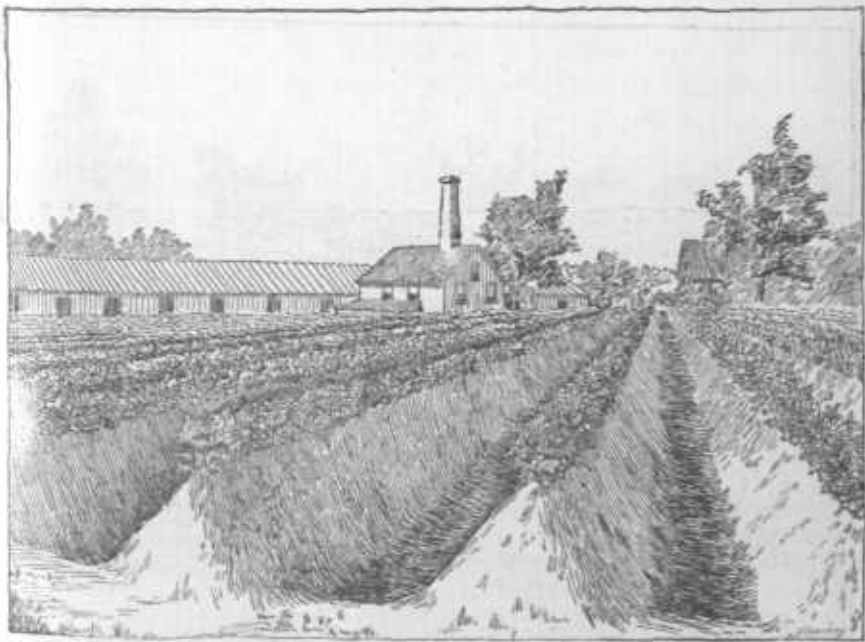


FIG. 1.—Blanching celery with earth.

are leaned against the plants on either side of the row and held in position by wire hooks, cleats, or other means. Drain tiles, stiff wrapping paper, and in Florida, according to an agricultural journal, moss are sometimes used for bleaching. Sometimes the plants are set so closely together that they shade and bleach themselves. This is the method employed in the so-called "new celery culture," which is simply the growing of varieties with self-blanching tendencies in rows 8 to 12 inches distant either way and banking or boarding up the outside rows only (fig. 3). This system of course necessitates an increase in the amount of fertilizers and water used.

At the Pennsylvania Station a test was made on the relative merits of blanching with earth and with boards. In some cases celery

blanched with boards was ready for market earlier than that blanched with soil, but the celery so blanched was decidedly inferior, and, as a rule, was long, slender, pithy, and bitter, while that blanched with soil was exceedingly large, crisp, and tender.

### SHADING.

The New Jersey Station reports experiments in shading growing celery. "Six varieties were tested in this way, and all grew to more than double the size of other plants of the same lot that were in the full sun, but later in the season, with shorter days and less light, the exposed plants overtook and surpassed the shaded ones."

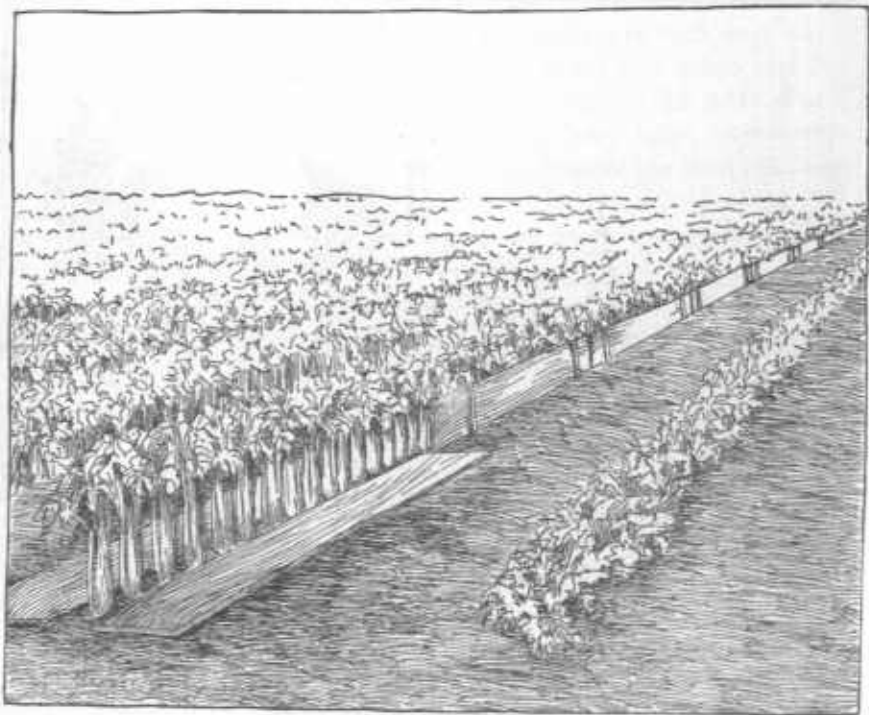


FIG. 2.—Blanching celery with boards.

### IRRIGATION.

Celery requires an abundance of water for its growth. In experiments in the surface irrigation of celery at the New Jersey Station the soil of the celery plat was not the most favorable, but the yield on the irrigated plat was 42 pounds, while the unirrigated plat gave only 17½ pounds. The market value of the crop produced from the irrigated plat was eight times that produced without the aid of artificial watering. The loss from outside leaves and roots in preparing the

plants for market was 28 per cent in the case of the irrigated plats, against 40 per cent in the nonirrigated plats. At the South Dakota Station celery irrigated four times, with a total of 8 inches of water, developed bunches 4 inches in diameter and 30 inches long. The stalks were crisp, tender, and of a fine, nutty flavor. The successful subirrigation of celery through rows of drain tiles has been reported from the Michigan Station. Two-inch drain tile was laid 6 inches under the soil surface. The tiles were left from one-eighth to one-fourth inch apart at the ends for the water to pass out. A good crop of celery, excellent in quality and free from rust, was grown by this method during a season of drought. The following year a few rows, purposely surface irrigated rather than subirrigated, did not

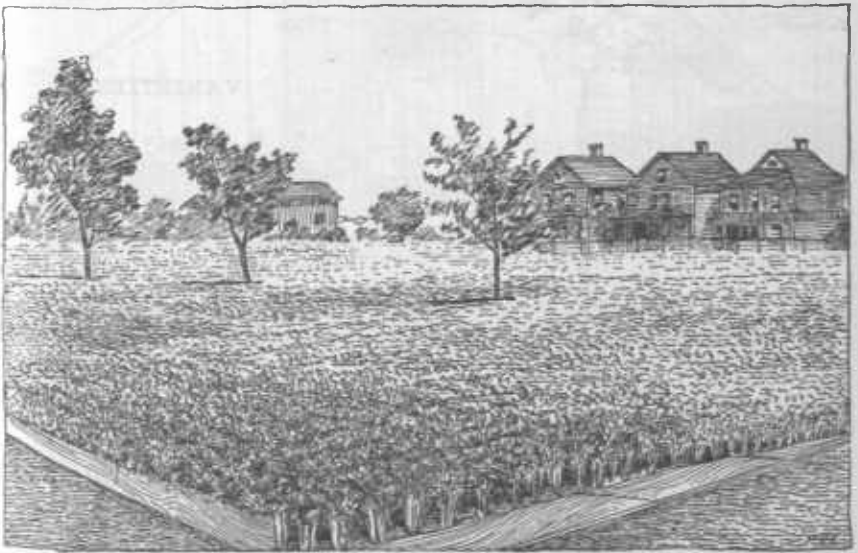


FIG. 3.—The "new celery culture" method of blanching.

give so good growth, and much more rust was present than in the subirrigated rows. When the drain tiles were 18 inches below the surface the Rhode Island Station secured better results with surface irrigation than with subirrigation.

### FORCING.

The New York Cornell Station reports results in forcing celery for the purpose of supplying the early market demand for this crop in May or June. The seed was sown in late fall or early winter in flats and transplanted twice at intervals of about a month. About six weeks or two months after the plants were set in permanent positions they were ready for bleaching. In the experiments reported all the usual methods of bleaching were tried, but without success. When, however, the

plants were wrapped with a thick, hard wrapping paper with an almost "sized" surface, the bleaching was successful. By this method "the stalks were brought together and tied and a width of paper reaching to within 2 or 3 inches of the tops of the leaves was rolled tightly about the plants (fig. 4). As the plants grew another width of paper was rolled about the first, and again reaching nearly the top of the plant." Two applications of the paper were found to be sufficient. From a month to six weeks was required to bleach the celery by this

process in a cool house in April and May. The Kalamazoo variety of celery was found to be well adapted to house cultivation.

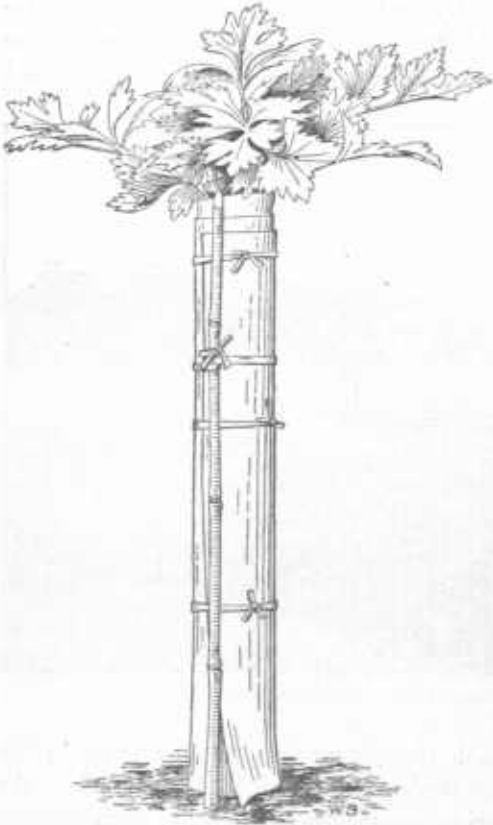


FIG. 4.—Blanching celery with paper.

#### VARIETIES.

L. F. Kinney has made a study at the Rhode Island Station of the principal varieties of celery which have been cultivated in this country during the past fifty years, "the chief object being to note the successive steps in the onward march of the species to a higher domesticated state." The principal modifications that the celery plant has undergone in the last half century are the greater localization of the fleshy growth in the center of the plant, self-blanching tendencies, and earlier matur-

ity. According to Professor Kinney the varieties that have been recognized by growers as having special merit are Sandringham (Incomparable Dwarf), Boston Market, Golden and Golden Heart, White Plume, Rose, Paris Golden, and Giant Pascal. The Paris Golden or Golden Selfblanching celery is the variety generally grown in the local market gardens of Rhode Island.

Summarizing for the different stations, success has been oftenest reported with White Plume, Paris Golden or Golden Selfblanching, and Giant Pascal. The Paris Golden is preferred, according to the

Rhode Island Station, by market men, because it never has the strong, bitter flavor sometimes present in White Plume not properly blanched. White Plume seems to be more resistant to the black heart disease than the Paris Golden. Giant Pascal is one of the largest varieties grown.

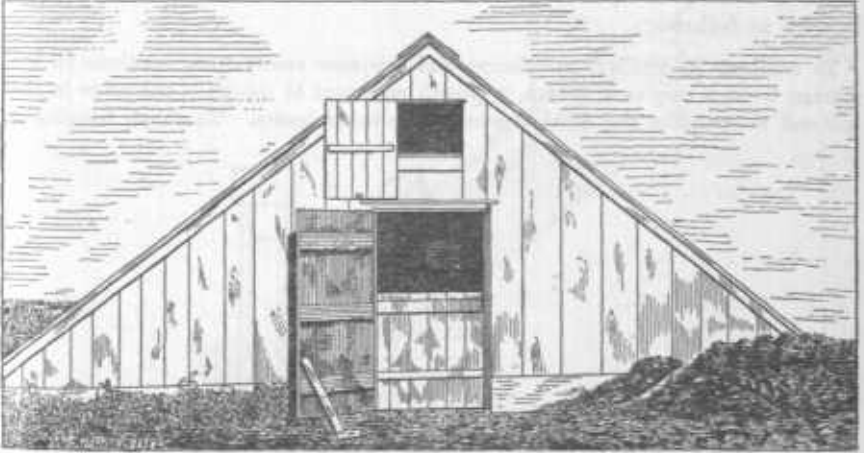


FIG. 5.—Exterior of an improved storage cellar for celery.

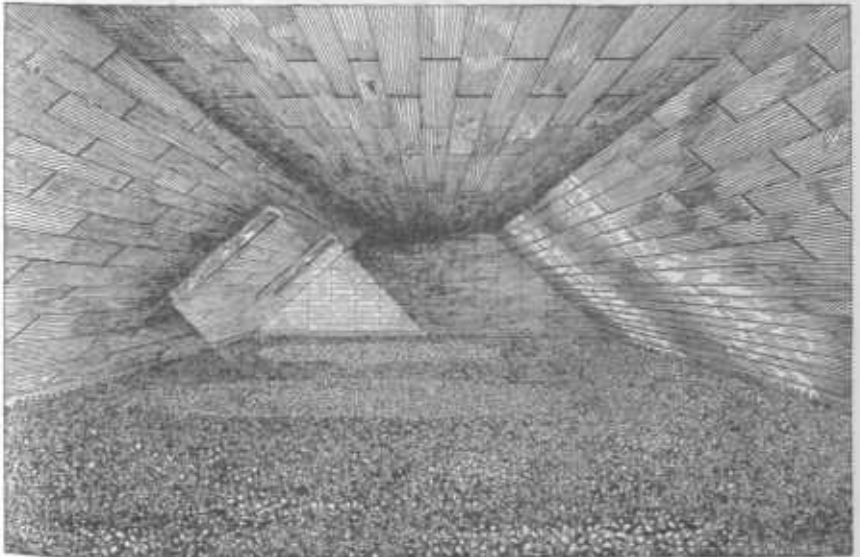


FIG. 6.—Interior of an improved storage cellar for celery.

### STORING.

The storing of celery for the late winter trade is an important problem in the North; but, according to the Rhode Island Station, “the present methods of keeping it are defective for commercial purposes,

in being either too wasteful or requiring too much labor. Observation and experience lead us to believe that the best winter celery is that which is protected by covering it with earth and forest leaves in the field where it is grown, without disturbing the roots until it is wanted for use." B. M. Duggar, of the New York Cornell Station, discusses the principles involved in the construction of celery storage houses as follows:

To continue its vitality, succulence, and crispness celery must continue in the storage house a very slow growth, a growth sufficient to establish the roots in the soil and to complete the development of the inner leaves. Thorough freezing is

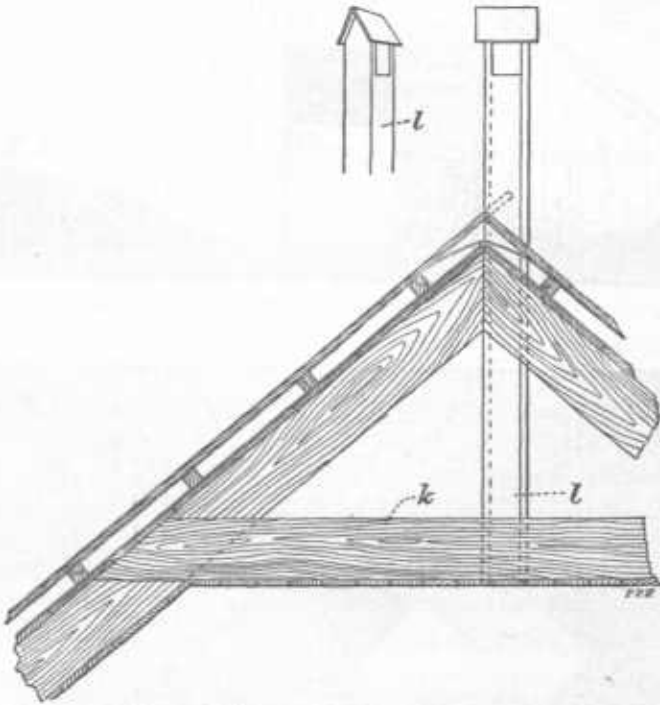


FIG. 7.—Construction of peak, collar beam, and ventilator of an improved storage cellar for celery.

fatal, but the lowest temperature at which freezing will not take place is most desirable. Not only does this temperature hold the plant in the desired condition of greatly suspended activities, but it renders next to impossible the growth of injurious fungi, which would speedily wilt and rot it. In order, then, to approach the temperature sought, the house should be so snugly constructed as to provide against freezing. Again, it should be so provided with ventilating appliances that at any time advantage may be taken of any cold intervals to rapidly and effectually chill the house, after which it might be securely closed for a warmer period; and with this inclosed lower temperature remain for a time at a point more nearly that desired.

The accompanying illustrations show the general appearance and some of the details of construction of an improved celery storage house, as set forth in a bulletin of the New York Cornell Station. (See figs. 5, 6, 7, 8.)

With the usual excavation of 18 inches or 2 feet, this structure has a brick foundation, and the roof is well provided with air chambers and paper linings, affording the best protection against cold. The addition of a large air chamber above the collar beams, with its separate windows, seems also desirable. There are large double doors at each end, and the space between each outer and inner door is large and the connections well arranged for the exclusion of cold air.

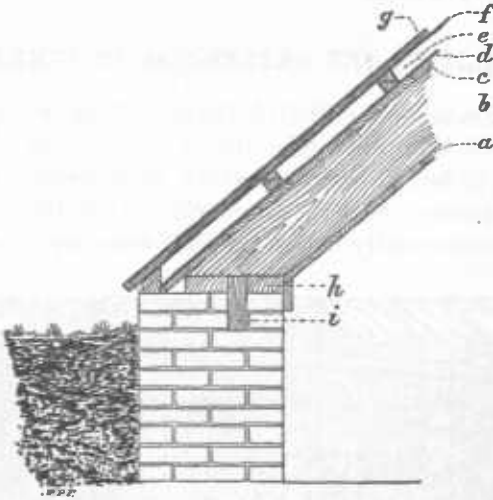


FIG. 8.—Detail of construction of roof of an improved storage cellar for celery.

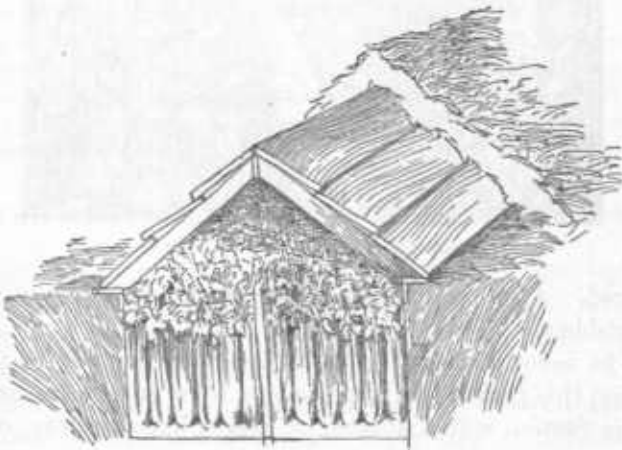


FIG. 9.—A form of storage trench for celery.

Fig. 7 shows the construction of the peak and collar beam (*k*) of the house and also of the ventilator (*l, l*). Fig. 8 shows the detail of the roof construction. The plate (*h*) is held firmly to the wall by a tongue (*i*) let into the brickwork. The rafter is *b*. On this is a thickness of sheathing upon either side (*a, c*) with an air space at *e*, and outer sheathing at *g*, and building paper at *d* and *f*. The cost of labor and materials is about \$500. An interior view of this house is shown in fig. 6. \* \* \*

[There is] a cheaper and modified form of the above structure provided with a single air chamber outside of the rafters and first boarding, with tarred paper covering the final layer of boards. The odor of tar in the house has caused comment, but if the house is well aired and sunned before celery is admitted there seems to be no need to fear even local censure.

Fig. 9 shows a form of storage trench for celery which has given good results in Arkansas.

### UTILIZING THE GREENHOUSE IN SUMMER.

"During the summer months it is the prevailing custom," says F. W. Rane, of the New Hampshire Station, "to clean out the forcing houses, allowing them to lie idle until it is time to prepare for the fall campaign. The excessive heat in summer dries out the soil under glass quickly, and consequently much shading, watering, ventilating, etc.,



FIG. 10.—Muskmelons growing in a greenhouse in summer.

are required. Also, the crops ordinarily grown under glass are readily grown outside at this season."

It was to ascertain whether these houses might not be profitably used during this period that experiments were undertaken at the New Hampshire Station with a number of crops, like tomatoes, eggplants, peppers, sweet potatoes, pole beans, sweet corn, celery, melons, etc. The favorable results secured with pole beans and sweet corn have been noticed in a previous bulletin of this series.<sup>1</sup>

With tomatoes the seed was sown March 10, Early Acme, Beauty, New Liberty Belle, Ignatum, Fordhook First, and Bond Early Minnesota being used. The plants were set 18 inches apart each way and

<sup>1</sup>Experiment Station Work, XII (Farmers' Bul. 105, p. 13).

trained to single stems. The fruit began ripening July 10. The yield per square foot from this date until August 10, the usual time when tomatoes in New Hampshire begin to ripen in the field, averaged 2 pounds 6½ ounces. The average price of tomatoes for this period was 7 cents per pound, thus making the average income per square foot 16.8 cents. In 1897 the outdoor tomatoes did not ripen until August 30 and the income per square foot of surface for that year was 20 cents.

The unfavorable weather conditions of 1897 prevented the outdoor fruiting of eggplants and peppers. In the greenhouse large squash peppers yielded at the rate of 160½ pounds per square rod and the Ruby King 122 pounds per square rod. Of the eggplants grown, Early Long Purple and New York Improved were most satisfactory. The returns, per square foot, with eggplants was about 18 cents.

Sweet potatoes have not been a success in these experiments. The vines grow well, but few potatoes set. Celery was not as crisp and nutty as that grown out of doors, but it is believed that it can be made a profitable crop. Golden Selfblanching proved most suited for greenhouse growing. Muskmelons were started in pots and transplanted. It required three months from the time the seedlings were transplanted until the fruit matured. A space 7 by 50 feet yielded 330 fruits (fig. 10). With cucumbers the custom has been to utilize the same vines that have been bearing during the earlier spring, running them on until the crop begins to come in from the garden.

The following conclusions are drawn from this work:

From our experience it is evident that we can ill afford to allow the houses to remain idle throughout the summer. The conditions are easily controlled, and whatever the outside season may be, we are assured of, at least, these crops. Possibly this may not apply with equal force to those States farther south, but it is a subject worthy of consideration, we believe, in the more temperate sections, and especially in New England.

### THE RESISTANCE OF STRAWBERRIES TO FROST.

Throughout a large proportion of the strawberry-growing localities light frosts often occur in late spring, killing a variable percentage of the flowers and recently set fruit of the strawberry. The injury from such frosts appears first in the blackening of the pistils,<sup>1</sup> which occurs within a few hours after the frost. Fruit upon which the pistils have been injured by the frost either fails to develop or produces a small berry of irregular form.

On the grounds of the Montana Experiment Station it was observed that a considerable variation prevailed in the resistant power of different varieties of strawberries to frost. A frost which occurred in the spring of 1897 caused an average injury of 4 per cent in 58 varieties of strawberries, and the extent of damage in different varieties varied

<sup>1</sup>The fertile or female organ of the plant.

from 0 to 12 per cent. The variation in the amount of damage in different varieties suggested the possibility of differences in anatomical structure of the different varieties, which would account for the variations in result. A microscopical study was therefore made of the young fruit of a number of varieties of strawberries for the purpose of determining any such variation in structure. This investigation was concerned chiefly with a study of the injury from frost in young berries which had begun to develop and had attained various sizes up to that of a pea.

In general, it was found that injury to such fruits was confined to the achenes or seeds of the strawberry. The pulpy mass or receptacle was in no case injured, and the surface of the pulp did not become blackened or show any other changes which would indicate injury from the frost. The seeds in varieties which suffered injury were killed by the frost and rapidly showed discoloration and a decomposition of their tissues.

Upon studying thin sections of injured and uninjured strawberries of different varieties at the same immature stages of development, it was found that in those varieties which did not suffer from frost the seeds were more deeply embedded in the substance of the pulp than was the case in those varieties which were injured. In those varieties in which the seeds were so deeply embedded in the pulp that they were protected from the frost by a layer of tissue, the protruding styles or tips of the pistils were killed by the frost, as in the case of varieties where the seeds were also killed. It was noted, however, that although the surface of the berry at first exhibited the blackened tips of styles, the fruit proceeded with its development, and ultimately all trace of the injury disappeared.

In the varieties which were most damaged by the frost the seeds were most exposed upon the surface, and they were least exposed in those varieties which suffered least. In general, it was found that a somewhat regular series of gradations prevailed, extending from varieties which were uninjured to those which were most damaged.

It was found during this study that nine varieties of strawberries had escaped all injury from the frost. These varieties were Bisel, Crescent, General Putnam, Princeton Chief, Parker Earle, Robinson, Stevens, Shuster Genl. and Warfield—all of which have the seeds deeply embedded in the pulp. Varieties with short fruit stalks and long leaf stalks are less liable to injury from late spring frosts from the fact that their flowers are to some extent protected by the foliage.

It may be found upon further investigation that the conditions reported for Montana do not prevail in all localities. In localities where severe spring frosts occur after strawberries have begun their development it would naturally be advantageous to plant varieties which are especially resistant to frost, and a simple method for recog-

nizing variations in resisting power would enable the strawberry grower to make a selection of varieties with especial reference to possible injuries from frost.

### A FUMIGATOR FOR SMALL ORCHARD TREES.

Fumigation with hydrocyanic-acid gas has been recognized for some time as one of the most effective means of dealing with the San José scale and other scale insects. This method of treatment has been applied to nursery stock as well as to trees standing in orchards. The labor necessary for manipulating a tent or box covering for trees in orchards is under any circumstances considerable, and this gives importance to the problem of devising a cheap, easily managed, and effective covering for fumigating trees. V. H. Lowe, of the New York State Station, has recently described a fumigator designed for use on the smaller trees. The frame of this fumigator is constructed of pine strips 3 inches wide and seven-eighths inch thick, the strips being braced on three sides by double cross pieces midway between top and bottom and short braces at the angles, as shown in fig. 11. The base has but three sides, the fourth side being omitted so as to avoid the necessity of lifting the fumigator over the top of the tree. In order to strengthen the base, two strips extend from the back strip of the base to the front end of the side strips. Two stouter strips are bolted onto the sides at convenient height for carrying the fumigator. The fourth side is separate from the rest of the fumigator, is made of the same material, and fits tightly in place against the 2-inch flange on the face of the box.

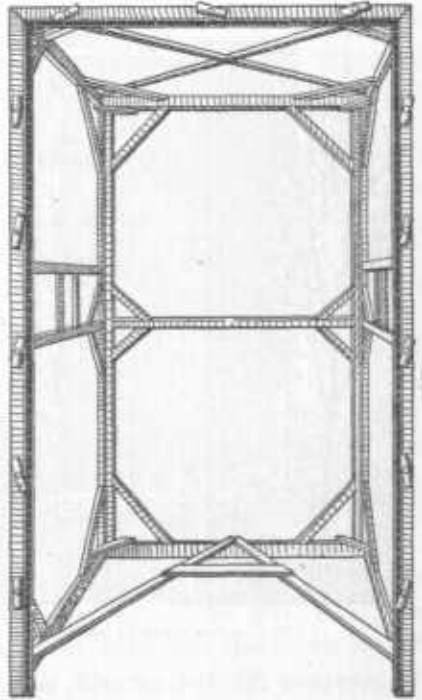


FIG. 11.—Framework of fumigator for fruit trees.

The frame is covered with any gas-tight material. Eight-ounce duck treated with raw oil and white lead or shellac and oil is suitable for this purpose. Canvas may be rendered dark in color by mixing lampblack with the oil. As an especial precaution against possible tearing of the canvas at the top of the fumigator a wire net may be

tacked on the inside of the frame so as to prevent the limbs from coming in contact with the canvas. The canvas may be sewed in such a manner that three sides are inclosed with one large sheet. Around the base of the fumigator a strip of canvas 18 inches wide is securely tacked and when the box is in place these strips lie on the ground and may be covered with dirt or, preferably, long sand bags of small diameter for preventing the escape of the gas. These strips may be fastened up out of the way when the fumigator is being moved. The movable face of the box rests upon a 2-inch flange which is covered with felt so as to prevent leakage. The surface of the movable side which rests against the flange is covered with the same material. This movable side is forced into position and held by wooden buttons firmly

bolted onto the frame.

The fumigator when closed and in operation is shown in fig. 12. The cost of the fumigator, 10 by 6 by 6 feet, will vary from \$13 to \$18, depending upon the quality of the sheeting which is used to cover the frame and whether wire netting is used in the top of the fumigator. A fumigator made according to this method may be carried and operated by two men. As already indicated, the movable side makes it unnecessary to lift the fumigator over the tree. For operating the apparatus a bag of cyanide of potash is

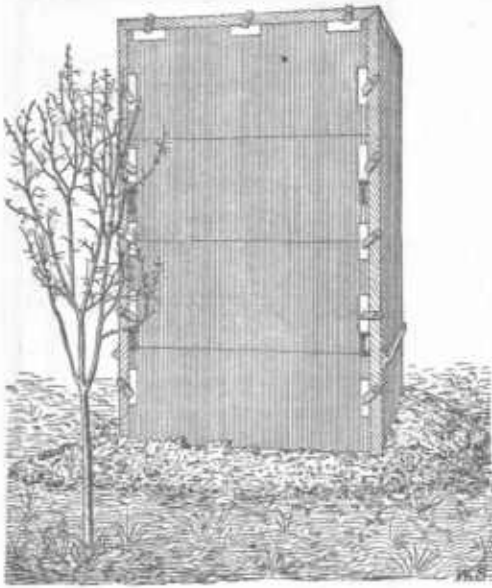


FIG. 12.—Fumigator in operation.

placed over the dish of acid, and a string tied to the bag is extended through a small hole in one of the strips of the frame. The string may then be gently pulled from the outside, when the cyanide will fall into the acid, after which the hole is closed with a wooden plug. The time required by two men for moving the fumigator from one tree to another and putting it in place was found to average about ten minutes during the experiments reported.

The chief advantages claimed for this fumigator may be stated as follows: Its cubic content may be easily and accurately computed, and hence the exact amount of chemicals necessary for the treatment of each tree is readily determined. The same amounts of chemicals will be used for each tree, and the necessity of separate estimations of amounts and weighings of chemicals in the field are thus avoided.

Fewer men are required to manipulate the fumigator than would be necessary to handle a tent large enough to cover trees of the same size. The fumigator does not rest upon the trees, and there is therefore little danger of injury to buds or of breaking small limbs. Trees which bear some long branches may be pruned sufficiently to admit them into the fumigator without injury. The frame of fumigators constructed in this manner was found to be rigid and sufficiently strong, and the whole proved to be gastight.

### FOUNDATION IN COMB BUILDING.

In a recent bulletin C. P. Gillette, of the Colorado Station, calls attention to the fact that experiments have shown that it requires about 1 pound of wax for every 25 pounds of honey which is stored in the comb. The food which is necessary for the formation and secretion of wax in the body of bees is for the most part honey, and it probably requires several pounds of honey as food for worker bees to enable them to produce 1 pound of wax. The bees which are engaged in the secretion of wax are thereby prevented from collecting honey, and must feed upon the honey collected by other workers. Where comb honey is being produced for the market, it becomes, therefore, a problem of considerable economic importance to determine to what extent and in what form wax should be furnished the bees for their use in building comb.

According to the present practice of bee raisers, wax is furnished to bees in only one general way, and that is in the form of artificial comb foundation. There are, however, many types of foundation, some with a midrib only and others with cell walls of greater or less length outlined for the bees. The keeper has, therefore, the practical problem of determining the kind of foundation to use, whether with or without cell walls, and of what weight. These and other related problems were investigated by Professor Gillette. Experiments conducted for the purpose of determining whether bees used wax from artificial foundations to extend the cell walls and the comb midrib showed conclusively that the bees used the wax for this purpose. It was found that none of the comb built upon foundation possessed a midrib as light as that of the natural worker comb, although in some instances the midribs of comb on very thin foundations were only slightly heavier than those of natural comb. It was determined that the midribs of foundations are thinned by the bees to some extent, but not sufficiently to correspond with those of natural comb. The midrib of any comb was left by the bees somewhat thicker near its attachment at the top, sides, or bottom than near the center of the frames. In cases of very thin midrib the bees drew it out little, if any, and where the midrib was considerable thinner than in natural comb the bees added wax to it, making it in some cases heavier than the normal comb.

It is apparent that a thickening of the cell walls will increase the weight of the comb more than the same amount of thickening on the midrib, and in order to avoid an undue proportion of wax in comb honey it is necessary to use a foundation which will cause the bees to make the cell walls as thin as possible. In comb built upon artificial foundation the heaviest part of the cell wall, except the extreme outer end, is close to the base of the cell. None of the foundations used in this experiment gave as thin cell walls as are found in natural comb, except the very thin super-foundation and a shallow cell foundation. These investigations indicate, therefore, that it is a mistake to use deep cells in artificial foundation, unless their walls are made of the thinness of natural cell walls. The only cell walls which were brought to the thinness of natural comb were those built on foundations with a light base and with little wax in the cell walls.

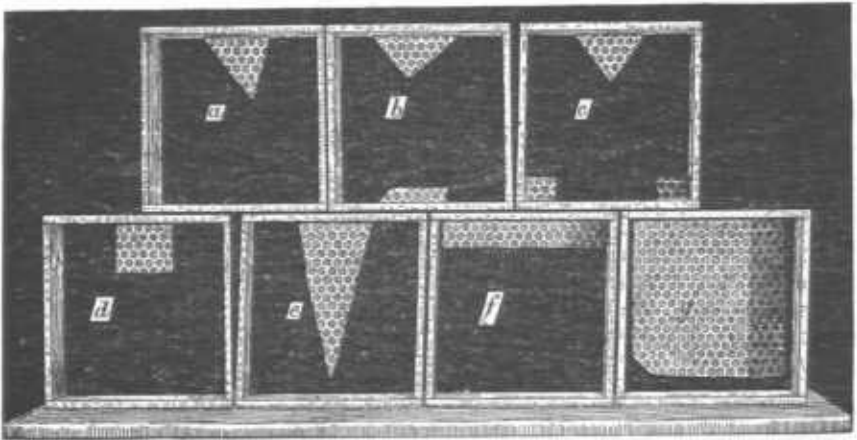


FIG. 13.—Different methods of attaching comb starters.

Comparisons of the weights of natural comb and comb built on artificial foundations showed that the thin and extra thin super-foundations are far the best for the production of comb which will compare in quality and lightness with natural comb. It was found that the increased weight of comb on artificial foundations was due rather to the extra wax in the cell walls than to the greater weight of the midribs in cases of heavy foundations. It seems certain, therefore, that heavy foundations result in combs heavier than the natural comb and that the increased weight is due to thicker midribs and thicker cell walls, but more to the latter than to the former. Where the cell walls were very high, they were not thinned down in the process of comb building.

The author attempted to determine to what extent the foundation lessened the secretion of wax by the bees. From the evidence obtained by an examination of 49 samples of comb it appeared that the wax secretion of bees was not lessened much, if any, more by the use of a

heavy foundation than by the use of a very light foundation. This is of considerable practical importance in increasing the consumption of honey, since many people dislike comb honey because of the large amount of wax contained in it.

Experiments were tried with a number of methods of using foundations in sections. The different methods of attaching starters are shown in fig. 13, *a* to *g*. No appreciable difference was noted in comb produced by using starters in the way shown in *a*, *c*, and *d*. The chief advantage of using a long, narrow piece, as seen at *e*, was that it had a tendency to induce the building of worker comb throughout. It had, however, the disadvantage that its large size and short line of attachment rendered it easy to be torn loose. Perhaps the best results were obtained by the use of a long, narrow piece at the top of the section, as shown at *f*. The use of small pieces of foundations in the lower corners, as shown at *c*, gave no beneficial results. The use of short strips in the middle of the bottom of the section, as shown at *b*, resulted in the somewhat firmer attachment of the combs. Comb built upon foundation is always tougher and more waxy than natural comb, and the bases of the cells are darker in color.

Since a thick comb has but one midrib and the walls of the cells are heaviest nearest the midrib, it is evident that a thick comb will contain relatively less wax and more honey than thin comb. In order to secure comb honey, therefore, with the least possible amount of wax, it is necessary to have it built in sections that will permit the greatest thickness of comb.

### A DEVICE FOR RIDDING HOUSES OF FLIES.

Few things are more annoying to the housekeeper than the various kinds of flies which get into the house or dairy in spite of all precautions to keep them out. When they once gain entrance it is very difficult to get rid of them. Wholesale poisoning is not always practicable, and few of the traps which have been devised heretofore have proved entirely satisfactory. The Kansas Station has been experimenting with various mechanical devices for catching flies and has devised what it believes to be a cheap and effective trap, which is described as follows:

Take a flat strip of tin  $2\frac{1}{4}$  inches wide and  $1\frac{1}{2}$  inches longer than the distance between the side rail or stile and middle rail of the sash, as from *c* to *d*, fig. 14, which in this case measured 21 inches. For this window, the strip must be  $22\frac{1}{2}$  inches in length. With the tin lying on a flat surface, bend the tin along the lines *ab* and *cd* (1), which are  $\frac{3}{4}$ -inch from their respective sides, so that the space *abcd* forms the bottom of a box and the lateral parts the sides. To close the ends, cut small incisions  $\frac{3}{4}$ -inch deep at the points *a*, *b*, *c*, and *d* (1). Bend the flaps thus made at right angles to their respective parts. We then have a box 21 inches long,  $\frac{3}{4}$ -inch wide, and  $\frac{3}{4}$ -inch deep, as at (2). To make the box water-tight, solder the joints, or if solder is not handy try moistened plaster of paris. When properly made the box should fit snugly between the middle and side rail or stile. The corners should be

square and the edges straight, so as to leave no passageway between the box and the glass. The box should rest on top of the bottom rail, and can be held in place by two or three tacks or pins thrust into the rail from the back side. When the pane is very large it is well to attach another trap halfway between the top and the bottom.

The method of using these traps is, in brief, as follows: "After the traps have been attached some substance should be put into them that will either kill the insect upon falling into it, or, on account of its sticky nature, will hold the insect, so that it can not escape. For the first, kerosene, kerosene emulsion, soapsuds, and pyrethrum are the best; and for the second, molasses, or a mixture of castor oil and resin." For general use,

strongsuds made from ordinary, common washing soap is recommended, filling the traps two-thirds full with the liquid. Kerosene is most fatal to the flies, but it must be used with care or it will soil the sash. In using it fill the trap half full with water and add enough kerosene to form a film.

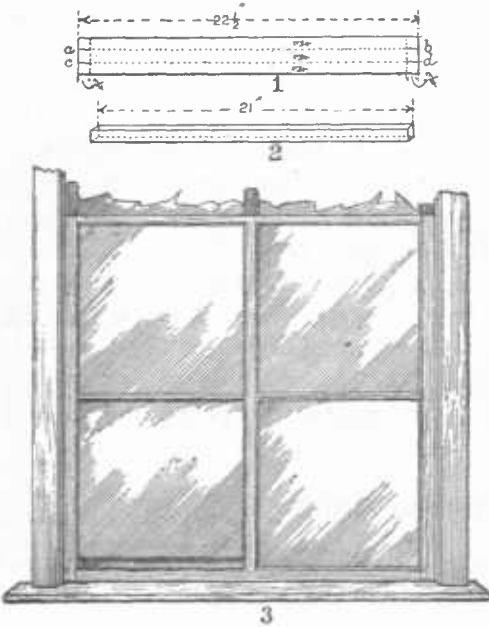


FIG. 14.—A device for catching flies.

There should be one trap for every pane of glass of at least one window in the house. For instance, when the sash contains two panes of glass there should be two traps, one at the base of each pane. When the sash contains four panes (fig. 14, 3) there should be four traps, two

on the bottom rail and two on the crossbars or muntings. It is not necessary to apply traps to all the windows. Attach traps to one or two windows in the sunny part of the house, and pull down the blinds of the remaining windows. The flies will seek the lighted rooms, and especially the windows.

When the traps are full of flies remove them from their fastenings, empty out their contents, and fill them with fresh material.

### SLOP FOR PIGS.

The Indiana Station has reported some data on a question which often arises in pig feeding, namely, What is the advantage of mixing the grain feed with water and how thick or how thin should slop be fed? Four lots of 4 pigs each were used in a test which covered some five months. For about three months all the pigs were fed corn meal and shorts 1:1. During the remainder of the time hominy feed

replaced the corn. Lot 1 was given the ration dry; lot 2 was fed the grain mixed with an equal weight of water, while in the case of lot 3 it was mixed with twice, and in the case of lot 4 three times its weight of water. In addition to the dry grain or slop, the pigs were supplied with all the drinking water they desired and the amount consumed recorded. The average daily gains of the four lots were in every case a little over 4 pounds per day; the grain required per pound of gain by the four lots was 3.59, 3.80, 3.74, and 3.75 pounds, respectively; while the cost of food per pound of gain ranged from 2.87 cents in the case of lot 1 to 3.04 cents in the case of lot 2. During the test lot 1 (fed the dry grain) drank 3,375 pounds of water; lot 2 did not receive all the water they desired in the slop fed and consumed a total of 3,031 pounds; lots 3 and 4 received all they desired in the slop, the amounts thus taken being 4,871 and 6,928 pounds, respectively. The figures recorded by the station show that—

Pigs weighing 60 pounds, fed dry feed, consumed on an average 2.35 pounds of water daily, and that this amount increased nearly constantly until these same pigs weighing 218 pounds consumed 11.07 pounds per day. It is also shown that pigs fed water in their food as a slop, when weighing about 60 pounds, consumed either 2.42, 4.25, or 5.79 pounds of water per day, while these same pigs weighing 213 to 222 pounds consumed either 8.17, 14, or 18 pounds of water per day. Undoubtedly much of this water was consumed unnecessarily, and certainly lot 4 was given much more water with its grain than was required.

There was no material difference in the appearance of the pigs in either lot, so far as quality is concerned, and so far as this one experiment goes, the use of about two times the weight of water to grain indicates a satisfactory proportion.

In view of the fact that the pigs fed dry grain made slightly better gains than those fed grain mixed with water in form of slops, "it would appear that there is really no gain in feeding the pigs a slop instead of a dry grain, excepting as a feeder may regard it a matter of convenience."

### PROFITABLE CROPS FOR PIGS.

Corn is doubtless generally regarded as the standard feed for pigs in this country. There are regions, however, where there is not sufficient moisture for corn and where other crops can be more successfully grown. In Kansas Kafir corn has been found especially valuable. Alfalfa and soy beans have also proved useful as drought-resisting crops. The feeding value of these crops has been tested by the Kansas Station for several years with some 300 pigs. The grain ration has usually consisted of Kafir corn. This has been supplemented by alfalfa hay, soy beans, cotton-seed meal, and skim milk in different amounts alone and in varying combinations.

In two tests it was found that a bushel of Kafir corn produced 10.6 pounds of pork, while with the lots fed corn or maize, for purposes of comparison, a bushel of grain produced 11.9 pounds of gain.

During the last eleven years the average yield at the Kansas Station has been, Kafir corn, 46 bushels; corn,  $34\frac{1}{2}$  bushels. An acre of Kafir corn would therefore produce, on the basis of the above figures, 487 pounds of pork, an acre of corn, 410 pounds. It is stated that the pigs tire of Kafir corn when it is fed alone more quickly than they do of maize. The Kafir corn is eaten with great relish at first and for about four weeks gains are made as rapidly as on maize. When the Kafir corn is not eaten readily other feed should be given with it. Kafir corn fed with alfalfa, soy beans, or skim milk is eaten readily until the pigs are thoroughly finished, and lots thus fed fatten evenly. Kafir corn is said to induce constipation, and its effect on the appetite is attributed to this.

When 7.83 pounds of alfalfa hay was fed per bushel of Kafir corn meal the gain was 10.88 pounds. The gain from a bushel of Kafir corn meal alone was 7.48 pounds. The gains were of about the same proportion when alfalfa hay was fed with Kafir corn. The value of alfalfa hay for combining with Kafir corn is evident. The station points out the need of cutting it early and curing it carefully. The leaves are the most valuable portion. The hay should be cut before more than half of the plants are in bloom and handled, so that as few leaves as possible are lost.<sup>1</sup>

When soy beans were fed with Kafir corn in the proportion of 1 to 4 there was an increase in gain from 14.6 to 96.4 per cent.

Pigs fed soy beans fatten rapidly, look thrifty, have strong appetites, and the hair and skin are glossy; like those of animals fed oil meal. The soy bean is a rich feed, and we do not recommend more than one-fifth to one-third of the ration to be made of the beans. Soy beans may be fed whole, mixed with the other grain, or unthrashed beans—stalk and all—may be thrown to the hogs and they will quickly pick out the beans.

When fed for a short time and in small quantities cotton-seed meal combined with Kafir corn also gave satisfactory results.

The best results were obtained with skim milk. In this case, the pigs fed skim milk and Kafir corn gained 169 per cent more than those not fed milk. Skim milk, when substituted for alfalfa hay in the proportion of 526 pounds to 214 pounds, reduced 50 per cent the amount of food required per pound of gain. Valuing Kafir corn at 55 cents per hundred and pork at 3 cents per pound, live weight, the calculated value of skim milk was 29 cents per hundred.

These experiments show that Kafir corn and either soy beans or alfalfa, properly combined, produce good results in fattening hogs. On an upland farm an acre of Kafir corn will produce more pork than an acre of corn. Kafir corn fed alone to hogs does not give nearly so large gains as when fed with soy beans or alfalfa hay. Kafir corn, combined with either soy beans or alfalfa hay, will produce more pounds of pork per acre from upland than are usually produced from adjoining bottom lands from corn. Kafir corn, or its near relatives, rice corn and Jerusalem corn, yield well in every part of the State. The experiments reported in this bulletin show that, by

<sup>1</sup>U. S. Dept. Agr., Farmers' Bul. 97 (Experiment Station Work, X, p. 15).

combining soy beans or alfalfa hay with Kafir corn, hogs may be fattened profitably on every farm in the State. Corn should be raised where it will yield more than Kafir corn, and Kafir corn where its yield is the higher.

Skim milk fed with Kafir corn made our best gains, and the patrons of Kansas creameries can increase their profits by feeding their skim milk with Kafir corn, using the methods of feeding which this bulletin shows to be the best.

### BARLEY AS FOOD FOR HORSES.

Except on the Pacific coast barley is not extensively used as a feed in the United States, doubtless owing to the fact that it is in such demand for brewing purposes that it is high in price. Wherever it is grown, however, it is frequently possible to secure at a low cost, grain which is off color, owing to rain or fog during harvest, and which, for this or some other reason, is unfit for brewing, but valuable as feed. The barley grown on the Pacific coast is extensively used in the feeding of horses. Its use for this purpose is old in other countries. The Arabs fed their horses unground barley, and it is used successfully by the Berbers of North Africa. In Europe its value is generally recognized. Barley may be fed whole to horses having good teeth and not required to do severe work. Since ground barley, like wheat, forms a pasty mass when mixed with saliva, it is regarded as more satisfactory to crush than to grind it, if for any reason it is considered undesirable to feed the grain whole. In composition, barley resembles oats and other cereal grains quite closely. The North Dakota Station has recently studied the value of barley as a feed for work horses and mules. For some months this grain was fed with timothy hay to three horses and two mules. The mules did not eat the barley with marked relish at any time, but for two months, during which time they were performing light work, they ate enough to keep them in condition. The work was then increased, but they would not eat a correspondingly greater quantity of barley, and soon began to refuse it altogether for a day or so at a time. The mules were then given oats on alternate months. This grain was eaten with relish, and gains in weight were made. Although the trial lasted nine months the mules persistently refused barley.

Of the horses mentioned above, two were work horses. They were fed alternately, barley and oats, with timothy hay for nine periods of twenty-eight days each. They ate the barley without regard to the amount of work required of them. On the oat ration there was an average daily gain of 0.38 pound per horse. On the barley ration there was an average daily gain per horse of 0.15 pound. In both cases the horses averaged 5.50 hours' work per day.

This trial indicates that horses, when taxed to the limit by hard work, can not be supported upon barley quite so well as upon oats, and that it is worth slightly less per pound than oats with stock which is given a medium amount of work. It indicates, further, that mules take less kindly to barley than do horses, and that horses which are inclined to be "dainty" eaters will not eat barley so readily as oats.

Malted barley was compared with oats in a trial made with four work horses. The two grains were alternated in different periods. Oat hay was supplied as coarse fodder. The malted barley was prepared as follows: After soaking in water for twenty-four hours, the grain was spread on the floor in a layer 6 inches or less in depth, and allowed to remain until the sprouts were  $\frac{1}{2}$  to  $\frac{3}{4}$  inch long; it was then fed. On the oat ration there was a daily gain of 0.49 pound and on the malted barley there was an average daily loss of 0.76 pound per horse. When fed malted barley, the horses ate 0.1 pound more grain than when fed oats. In this test the horses worked between five and six hours per day on an average.

A mixture of malted barley and bran was also compared with oats, the two rations being alternated as above. The grains were mixed in the proportion of two parts of barley (before malting) to one part of bran. As in the above test, oat hay was fed with the grain. The horses worked some seven hours per day. When fed a barley and bran ration, they ate an amount equivalent to about 17.4 pounds of dry grain per day. There was an average daily loss of 0.8 pound per horse. When fed the oat ration, an average of 16.2 pounds was consumed per day, and there was an average daily gain per horse of 0.22 pound. In other words, the horses did not maintain their weight on the bran and malted barley, although they ate a larger quantity than when the oat ration was fed.

These trials indicate that malted barley is not an economical feed for work horses, and that the addition of one part bran to two parts of malt, as measured by the dry barley, from which it was produced, is neither a cheap nor satisfactory feed for hard-worked horses.

### WATER IN BUTTER.

The average amount of water contained in American butter has been calculated as about 12 per cent. The quantity of this constituent, however, is quite variable, depending upon a number of conditions, some of which have recently been investigated.

At the Wisconsin Experiment Station a study was made of the effect of salt on the water content of butter. In each of 18 experimental churnings the butter was divided into two lots, one of which was salted and the other not salted. In other respects the two lots in each case received as nearly identical treatment as possible. In 8 trials both lots were worked once and in 10 trials the lots were worked twice, the two workings being separated by an interval of about twenty-four hours. Chemical analyses showed that the salted and unsalted butter in the lots worked once contained, respectively, 12.74 and 15.12 per cent of water. In the lots worked twice, the salted butter contained 10.53 and the unsalted butter 14.33 per cent of water. The unsalted butter always had a dry appearance, but in every comparison it was shown by chemical analysis to contain more water than the salted butter. The salt apparently made a difference of about 3 per cent in the water content of the butter.

The Wisconsin Station also studied the effect of the size of the butter granules on the water in butter. About 300 pounds of ripened cream was divided into two lots, one of which was churned in a box churn until the butter granules were about the size of clover seed, while the other lot was churned in a combined churn and worker until the butter granules were about the size of corn grains. Both lots were salted and worked to the same extent, except that one was worked on a table worker and the other in the combined churn and worker. Eleven trials of this kind were made. The average water content of the butter churned to large granules was 13.89 per cent and of the butter churned to small granules 12.15 per cent.

In experiments at the Iowa Station the water content of butter as influenced by the size of the granules and the temperature of the butter during working was studied. In each of a number of comparative tests cream was ripened, cooled, and divided into two equal lots, both of which were churned under uniform conditions, and were otherwise treated alike, except that one lot was washed with cold water and the other with comparatively warm water. In three of the comparisons, where the granules were of the same size, an average difference of about 25° F. in the temperature of the wash water made a difference of about 2½ per cent in the water content of the butter. The softer butter, resulting from the use of the warmer water in washing, contained in every case the most water. In one of the tests washing coarse granular butter with water at 45° was compared with washing fine granular butter with water at 70°. The percentage of water in the butter made in the two ways was, respectively, 14.07 and 17.50 per cent.

These experiments show that the presence of salt, the size of the butter granules, and the hardness of the butter are factors exerting an influence on the amount of water in the butter. Where a dry butter is desired, as for export, these principles may have considerable practical importance. By churning cream at a low temperature and continuing the churning until the granules were as large as peas, washing for about thirty minutes with water at 45° to 48°, and working twice, the Iowa Station secured butter containing as low as 6.72 per cent of water. Of 32 analyses of samples of butter made in this way, 7 showed less than 8 per cent of water, 7 from 8 to 10 per cent, and 10 from 10 to 12 per cent. It is not, however, advised that export butter should be made with less than from 9 to 10 per cent of water.

### LOSSES IN THE PREPARATION OF SILAGE.

In a recent report of the Wisconsin Station, Babcock and Russell, in discussing this subject, say:

The preservation of forage plants in silos is a question of such economic importance in agriculture that a thorough understanding of the causes operative in the production

of such material is desirable. When green plants are cut and placed in a heap, certain physical and chemical changes occur; the mass undergoes a rapid evolution of heat, and in a short time a marked chemical decomposition is to be observed. These changes take place when the material is stored in closely compacted stacks, in pits in the ground, or in air-tight receptacles. They are accompanied by a loss of dry matter, which is greatly increased by access of air, and various organic acids are formed, which give the silage a more or less sour taste. In practice these losses are subject to much variation, ranging from 3 to 40 per cent, depending upon the completeness with which air is excluded. In perfectly tight silos the losses are reduced to a minimum. Where the construction of the silo is such as to permit of leakage of air, molds and other ferments develop rapidly, resulting in largely increased losses. The losses may therefore be divided into (1) those which are unavoidable even in air-tight silos, and (2) those incident to faulty construction of silo.

The investigations of Babcock and Russell into the causes and processes of the changes which occur in the formation of good silage bring out the interesting fact that these are not due wholly to the action of bacteria as commonly supposed, since it was found possible to make silage of good quality and aroma without the presence of bacteria and without the generation of a temperature exceeding  $75^{\circ}$  to  $80^{\circ}$  F. The changes which take place in the silage are believed to be due to changes occurring in the tissues of the ensiled material.

As these processes are continued in immature and succulent plant tissues for a longer time than where the cells have reached their maturity, it naturally follows that the amount of acids present in silage made from immature corn is much greater than where more nearly matured fodder is ensiled. Not only is silage from immature corn of higher acidity, but putrefactive changes occur, due to the fact that bacteria capable of developing under anaerobic conditions are able to grow in the more succulent tissues. \* \* \*

The unavoidable losses in silage are due to the formation of water, carbon dioxide, and volatile organic acids which are produced [as a result of the intramolecular respiratory processes of the ensiled tissues]. As these changes are prolonged in the more active and immature tissues in comparison with the more mature, the losses in the first case are greater.

The avoidable losses, on the other hand, are due mainly to the decomposition of organic matter induced by the development of bacteria and molds, the growth of which is greatly facilitated by the admission of air as a result of the imperfect construction of the silo. This same imperfection also prolongs the direct respiration of the plant tissues, thereby increasing the amount of water and carbon dioxide produced.

King has shown that the unavoidable losses, i. e., "the loss of feeding value which can not be prevented in the interior of a silo with air-tight linings when filled in the best practicable manner" may be reduced as low as 2 to 4 per cent, and in good practice need not exceed 4 to 8 per cent. The main precautions to be observed seem to be a well-constructed air-tight silo, the use of mature crops, and careful packing, so that as little air as possible is inclosed in the mass when the silo is filled.